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COMPLETE SPECIFICATION

Treatment of Polyethylene

We, CELANESE CORPORATION OF AMERICA, of 180 Madison Avenue, New York 16, New York, United States of America, a company incorporated in accordance with the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the treatment of polyethylene and relates more particularly to an improved process for the flame treatment of polyethylene surfaces to improve their characteristics.

When a polyethylene surface is printed with conventional printing inks, the printed matter does not have a strong adhesion to the polyethylene surface and tends to break away from said surface with normal handling. Improvement has been obtained in the adhesion of the printed matter to the polyethylene surface by subjecting said surface to a treatment with an open flame. Some improvement is obtainable even by passing the surface to be treated close to a flame or other source of radiant heat as described in Specification No. 704,665.

The present invention provides an improved flame treatment that can be carried out at high speed and with little or no deleterious effect on the ageing characteristics of the material treated. From polyethylene films flame-treated according to the invention, strong heat-seals can be obtained between the treated surface and other polyethylene surfaces (flame-treated or not) and between different parts of the treated surface, whether or not the sealing be done immediately or after ageing. Hence the treatment is particularly valuable when the polyethylene film is to be made into bags or wrappings by methods involving heat-sealing. Moreover, the good receptivity to printing ink is retained by surfaces flame-treated according to the invention even after ageing.

In the process of the present invention the polyethylene surface is treated by contact with a flame having a temperature of at least 4,000°F., and preferably from 4,200—5,000°F., under such conditions that the heated surface cools rapidly so that the object being treated is not distorted.

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Preferably the flame is so positioned with respect to the polyethylene surface that the latter passes through the secondary cone of said flame at a point between the tip of the primary cone and about ½ to 2½ primary cone lengths, or preferably about 1 primary cone length spaced from said tip. In addition, the flame is so inclined with respect to the polyethylene surface that the said surface is bathed by the secondary cone of the treating flame and is thereby pre-heated before passing through the treating zone. Advantageously, in carrying out the treatment, the polyethylene surface and the flame are positioned with respect to one another in such a manner that the products of combustion, such as water vapour, do not condense on the polyethylene surface so that no drying of the latter is necessary.

The treatment of the polyethylene surface may be carried out over a relatively wide range of treating speeds or treating times. In addition, extremely high treating speeds or short treating times may be used so that a given piece of treating equipment can treat a large area of polyethylene surface. The treated polyethylene surfaces show good ink adhesion both immediately after the flame treatment and after extended ageing. The heat-sealing characteristics of the treated surfaces are excellent and said surfaces may be readily sealed to other polyethylene surfaces, whether flame treated or not, to form a strong bond.

One of the outstanding features of the invention is the extremely rapid transfer of heat by reason of the high temperature flame. This heating is so fast with the high temperature flame, especially when the speed of the moving film is high, that the surface only of the film may be heated, while the remainder of the film

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does not soften and distort, as would be the case with a flame of greater size but lower temperature.

In a preferred manner of carrying out this invention, the treating flame is produced by burning a mixture of oxygen and a fuel gas such as propane, butane, ethane, ethylene, acetylene, natural gas, or a mixture of such gases. The use of an oxygen-fuel gas mixture enables the desired temperatures to be readily achieved with a flame having a small volume, whereby important economies can be achieved in the quantities of fuel gas and oxygen that are required to treat a given surface area of the polyethylene. Also, because of the relatively small quantities of fuel gas that are burned during the treatment, the volume of the products of combustion will be at a minimum so that there will be little or no difficulty with condensation of the water vapour from the gas on the polyethylene surface and no need for drying the treated surface. While the proportions of the hydrocarbon and oxygen may be regulated to give a neutral, reducing or oxidizing flame, with corresponding changes in flame temperature, the best results are achieved with a neutral or slightly reducing flame.

The process of the invention will now be described in connection with the flame treatment of the surface of a polyethylene film. It should be understood, however, that the process may also be employed for treating the surfaces of other objects made of or coated with polyethylene to improve the adhesion to said surfaces of printing inks and the like.

Apparatus suitable for carrying out the process of this invention is shown by way of example in the accompanying drawing wherein:

Fig. 1 is a side elevational view of the apparatus, and

Fig. 2 is a detail view, on an enlarged scale, of a portion of the apparatus shown in Fig. 1.

Referring now to the drawing, the reference numeral 11 designates a polyethylene film which is drawn from a supply roll 12 and passed around a guide roll 13. This directs the said film on to a treating roll 14 which is driven and is also cooled in any suitable manner, as by passing a cooling fluid therethrough. The film 11 then passes under a guide roll 15 and between nip rolls 16, which are positively driven in any suitable manner, and over a guide roll 17 to a take-up roll 18. As the film 11 travels around the cooled treating roll 14, it passes through a flame 19 of a torch assembly, indicated generally by reference numeral 21. The flame 19 is formed of a primary cone 22 and a secondary cone 23. The torch assembly 21 is supported by means of a clamp 24 which permits the said assembly to be moved axially along its length. The clamp 24 is in turn fastened to a bracket 25 by means of a swivel 26, and the said bracket is adjustably secured to a pedestal 27. By the use of oxygen-fuel gas mixtures, a very small, narrow burner yielding a flame with a primary cone as short as $\frac{1}{8}''$ can be used, so that the entire unit may be placed with the flame 19 in close proximity to the polyethylene film 11.

During operation, the torch assembly 21 is adjusted with respect to the treating roll 14 in such a manner that the polyethylene film 11 will pass through the secondary cone 23 at a distance from the primary cone 22 as specified above. Fig. 2 of the drawing shows the flame 19 as it would appear when burning freely in air and, in broken lines, the relative positions of the treating roll 14 and the film 11 with respect to the flame. In an actual run, the flame 19 will strike the polyethylene film 11 and the secondary cone 23 will be distorted. The torch 21 is so positioned with respect to the treating roll 14 that the said roll will carry the polyethylene film 11 through a large portion of the secondary cone 23 of the flame 19 so as to preheat the film. In addition, the torch 21 is inclined with respect to the roll 14 so that the axis of the flame is perpendicular to that of the roll and strikes the film on the roll at an angle that is at least 10° and preferably between 20 and 80° when measured from the side from which the polyethylene film leaves the flame. It has been found that when the torch 21 is inclined in this manner, the stability of the flame 19 is at a maximum as is the uniformity of the treatment. When the torch 21 is not so inclined, there is a tendency for the air currents produced by the movement of the polyethylene film 11 to cause the flame 19 to waver with the result that the uniformity of treatment is impaired.

The following examples illustrate the invention.

Example 1

A polyethylene film was treated with a neutral oxygen-propane flame having a temperature of 4700°F. in the apparatus shown in the drawing, the polyethylene film passing through the secondary cone of the flame, one cone length from the tip of the primary cone. In this apparatus, the burner tip comprised a single row of individual flames spaced $\frac{1}{8}''$ apart and having an orifice diameter of approximately 0.025". Satisfactory ink adhesion and heat seals were obtained with treating speeds ranging from 210 to 680 feet per minute. The slip and blocking characteristics of the treated film were excellent. When the temperature of the treating flame was reduced to 2600°F., substituting air for oxygen and using suitable burner equipment for this fuel gas-air mixture, satisfactory ink adhesion was observed over a narrow range of treating speeds, but heat sealing was unsatisfactory both initially and after ageing (three months at 70—80°F. or seven days at 110°F.).

The polyethylene film treated with the oxygen-propane flame was aged at 110°F. and retained its ink adhesion and ability to heat seal after 30 days of ageing.

Example 2

A polyethylene film was treated with a slightly reducing flame produced by the combustion f propane in oxygen and having a temperature of 4400°F., the film passing through the secondary cone of the flame two cone lengths from the tip of the primary cone. Good ink adhesion and heat sealability were obtained with treating speeds between 350 and 600 feet per minute. Both ink adhesion and heat sealability were still satisfactory after ageing for 6 months at 70—80°F. or 20 days at 110°F.

What we claim is:—

1. Process for treating a polyethylene surface which comprises treating said polyethylene surface by contact with a flame having a temperature of at least 4000°F., under such conditions that the heated surface cools rapidly so that the object being treated is not distorted.

2. Process according to Claim 1, wherein the flame has a temperature of 4200 to 5000°F.

3. Process according to Claim 1 or 2, wherein the treatment comprises passing the surface to be treated through the secondary cone of a flame at a position between the tip of the primary cone of the flame and a point about $\frac{1}{2}$ to $2\frac{1}{2}$ primary cone lengths spaced from said tip.

4. Process according to any of Claims 1 to 3, wherein the flame is formed by burning fuel gas with oxygen.

5. Process according to any of Claims 1 to 4, wherein the treatment is applied to a polyethylene film while said film is passing round a treating roll contacting that surface of the film which is not being treated.

6. Process according to Claim 5, wherein the axis of the flame is perpendicular to that of roll and strikes the film on the roll at an angle which is at least 10° measured from the side from which the film leaves the flame.

7. Process according to Claim 6, where the said angle is 20 to 80°.

8. Process for treating a polyethylene surface substantially as hereinbefore described.

9. Process for treating a polyethylene surface substantially as described in any of Examples 1 to 2.

10. Apparatus for treating a polyethylene film substantially as shown in the accompanying drawing.

11. Products comprising a polyethylene surface that has been treated as described in any of Claims 1 to 9.

12. A polyethylene film that has been rendered receptive to printing on one surface only by subjecting that surface to contact with a flame of temperature at least 4000°F. while the other surface is in contact with a cooled rotating roll over which the film is running.

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783,664 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

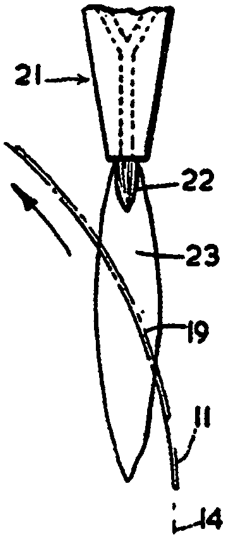

FIG. 2

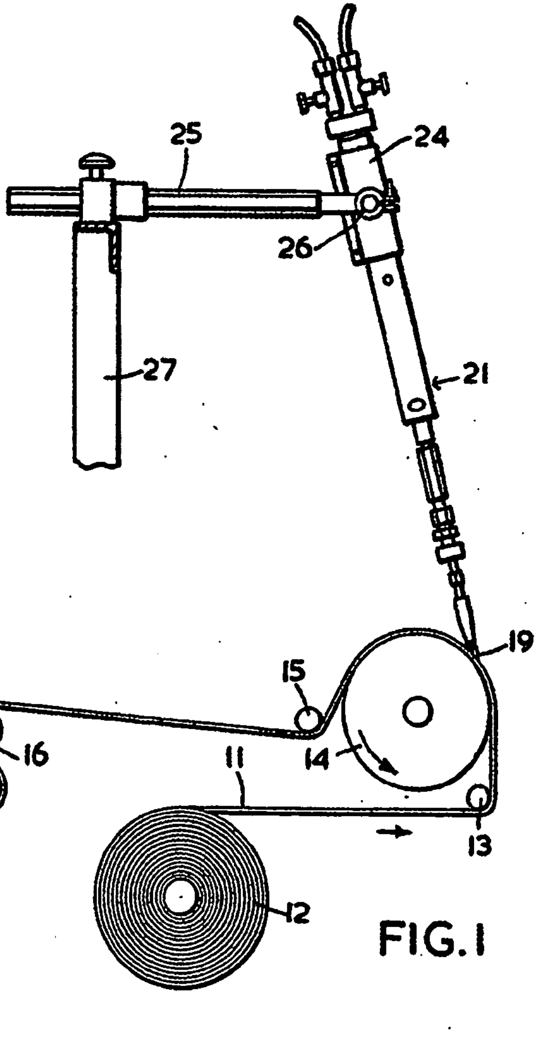

FIG. 1